APPENDIX A
International Allocations

In all three regions, the 1710-2290 MHz band is allocated on a primary basis to the fixed and mobile service. TABLE A-1 shows that there are numerous primary and secondary uses that are not fixed or mobile services. Applicable footnotes for this allocation are also shown in TABLE A-1.

TABLE A-1 (page 1 of 3)
INTERNATIONAL ALLOCATIONS IN THE 1710-2290 MHz BAND

<table>
<tr><th>Region 1
Allocations</th><th>Region 2
Allocations</th><th>Region 3
Allocations</th><th>Remarks</th></tr>
<tr><td colspan="3"><u>1710-1930 MHz</u>
FIXED
MOBILE 740A
722 744 745 746 746A</td><td></td></tr>
<tr><td><u>1930-1970 MHz</u>
FIXED
MOBILE
746A</td><td><u>1930-1970 MHz</u>
FIXED
MOBILE
Mobile-Satellite
(Earth-to-space)
746A</td><td><u>1930-1970 MHz</u>
FIXED
MOBILE
746A</td><td></td></tr>
<tr><td><u>1970-1980 MHz</u>
FIXED
MOBILE
746A</td><td><u>1970-1980 MHz</u>
FIXED
MOBILE
MOBILE-SATELLITE
(Earth-to-space)
746A 746U 746X</td><td><u>1970-1980 MHz</u>
FIXED
MOBILE
746A</td><td></td></tr>
<tr><td colspan="3"><u>1980-2010 MHz</u>
FIXED
MOBILE
MOBILE-SATELLITE (Earth-to-space)
746A 746U 746X</td><td></td></tr>
<tr><td colspan="3"><u>2010-2025 MHz</u>
FIXED
MOBILE
746A</td><td></td></tr>
<tr><td colspan="3"><u>2025-2110 MHz</u>
FIXED
MOBILE 747A
SPACE RESEARCH (Earth-to-space)(space-to-space)
SPACE OPERATION (Earth-to-space)(space-to-space)
EARTH EXPLORATION-SATELLITE
(Earth-to-space)(space-to-space)
750A</td><td></td></tr>
<tr><td colspan="3"><u>2110-2120 MHz</u>
FIXED
MOBILE
SPACE RESEARCH (deep space)(Earth-to-space)
746A</td><td></td></tr>
</table>

TABLE A-1 (page 2 of 3)
INTERNATIONAL ALLOCATIONS IN THE 1710-2290 MHz BAND

Region 1 Allocations	Region 2 Allocations	Region 3 Allocations	Remarks
<u>2120-2160 MHz</u> FIXED MOBILE 746A	<u>2120-2160 MHz</u> FIXED MOBILE Mobile-Satellite (space-to-Earth) 746A	<u>2120-2160 MHz</u> FIXED MOBILE 746A	
<u>2160-2170 MHz</u> FIXED MOBILE 746A	<u>2160-2170 MHz</u> FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 746A 746U 746X	<u>2160-2170 MHz</u> FIXED MOBILE 746A	
	<u>2170-2200 MHz</u> FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 746A 746U 746X		
	<u>2200-2290 MHz</u> FIXED MOBILE 747A SPACE RESEARCH (space-to-Earth)(space-to-space) SPACE OPERATION (space-to-Earth)(space-to-space) EARTH EXPLORATION-SATELLITE (space-to-Earth)(space-to-space) 750A		

722 In the bands 1400-1727 MHz, 101-120 GHz and 197-220 GHz, passive research is being conducted by some countries in a programme for the search for intentional emissions of extra-terrestrial origin.

744 The band 1718.8-1722.2 MHz is also allocated to the radio astronomy service on a secondary basis for spectral line observations. In making assignments to stations of other services to which the band is allocated, administrations are urged to take all practicable steps to protect the radio astronomy service from harmful interference. Emissions from space or airborne stations can be particularly serious sources of interference to the radio astronomy service (see Nos. 343 and 344 and Article 36).

745 Subject to agreement obtained under the procedure set forth in Article 14 and having particular regard to tropospheric scatter systems, the band 1750-1850 MHz may also be used for space operation (Earth-to-space) and space research (Earth-to-space) services in Region 2, in Afghanistan, Australia, India, Indonesia, Japan and Thailand.

TABLE A-1 (page 3 of 3)

INTERNATIONAL ALLOCATIONS IN THE 1710-2290 MHz BAND

746 Additional allocation: in Bulgaria, Cuba, Hungary, Mali, Mongolia, Poland, the German Democratic Republic, Roumania, Czechoslovakia and the U.S.S.R., the band 1770-1790 MHz is also allocated to the meteorological-satellite service on a primary basis, subject to agreement obtained under the procedure set forth in Article 14.

746A The frequency bands 1885-2025 MHz and 2110-2200 MHz are intended for use, on a worldwide basis, by administrations wishing to implement the future public land mobile telecommunication systems (FPLMTS). Such use does not preclude the use of these bands by other services to which these bands are allocated.

746U In the United States of America, the use of the bands 1970-2010 MHz and 2160-2200 MHz by mobile-satellite service shall not commence before 1 January 1996.

746X The use of the bands 1970-2010 MHz and 2160-2200 MHz by the mobile-satellite service shall not commence before 1 January 2005 and is subject to the application of the coordination and notification procedures set forth in Resolution COM5/8. In the band 2160-2200 MHz coordination of space stations of the mobile-satellite service with respect to terrestrial service is required only if the power flux-density produced at the Earth's surface exceeds the limits in No. 2566. In respect of assignments operating in this band, the provisions of Section II, paragraph 2.2 of Resolution COM5/8 shall also be applied to geostationary transmitting space stations with respect to terrestrial stations.

747A In making assignments to the mobile service in the bands 2025-2110 MHz and 2200-2290 MHz, administrations shall take into account Resolution COM4/2.

750A Administrations are urged to take all practicable measures to ensure that space-to-space transmissions between two or more non-geostationary satellite, in the space research, space operations and Earth Exploration-satellite service in the bands 2025-2110 MHz and 2200-2290 MHz, shall not impose any constraints on Earth-to-space, space-to-Earth and other space-to-space transmissions of those services and in those bands between geostationary and non-geostationary satellites.

APPENDIX B
EXTRACTS OF NTIA REPORT 92-285

The extracted summary findings of NTIA Report 92-285 for the 1710-1850 MHz band is contained herein. In general, the 1710-1850 MHz band supports fixed, mobile and space systems; however, the fixed microwave systems are primary medium capacity used by the Federal Government. In addition, the band is also the primary tracking, telemetry and command (TT&C) uplink band for Federal Government satellite systems. The average annual frequency assignment growth rate in the band is about 15% (i.e., 1250 assignments in December 1978 to 5539 assignments in March 1990). It should be recognized, however, that the 1710-1850 MHz band cannot be measured alone without the dependent space operation band, 2200-2290 MHz band. The growth trend in the 1710-1850 MHz band, and the continued capital investment into space systems in the 2200-2290 MHz band, definitely indicates the continued importance of these bands to the Federal Government and the entire nation.

1710-1850 MHz Band

a. Nationally, the 1710-1850 MHz band is allocated exclusively to the Federal Government for the fixed and mobile services on a primary basis with the Earth-to-space transmissions for certain space operations being accommodated on a co-equal basis in the 1761-1842 MHz portion of the band. Footnotes 722, US256 and G42 apply.

b. Internationally, the 1710-1850 MHz range is allocated exclusively for fixed and mobile services in Regions 1, 2, and 3 on a primary, co-equal basis, except in Region 1 where the mobile is secondary to the fixed service.

c. Internationally, Earth-to-space transmissions in the 1750-1850 MHz frequency range is allowed in Region 2 and several other countries for space operation and space research services.

d. Radio astronomy observations are being carried out at several facilities in the United States on the spectral line due to the hydroxyl radical (OH) at a rest frequency of 1720.530 MHz on an unprotected basis.

e. The 1710-1850 MHz band is the predominant federal medium-capacity fixed point-to-point band. The fixed is the predominant service used in the band. About 87% of the total assignments in the band are for systems operating in the fixed service.

f. Currently, 22 agencies have assignments in this band. The primary users of the band are shown in TABLE B-1.

g. Over the past 11 years, the number of assignments has increased almost fivefold. The average annual assignment growth rate in the band is approximately 15%.

TABLE B-1
GMF ASSIGNMENTS BY AGENCY IN THE 1710-1850 MHz BAND

Agency	Number of Assignments	Percent of Total Assignments[a]
Agriculture	1373	25
Army	790[b]	14
Justice	722	13
Energy	652	12
Air Force	640	12
Navy	450	8
Others	912	16

[a]The percentages of the total assignments are rounded-off.
[b]Does not include the temporary assignments that support the area-wide command and control network system.

h. A wide variety of systems are employed in the band characterized by at least 36 emission types and a range of authorized emission bandwidths from 40 kHz to 70 MHz. The most predominant emission type is F9W (FDM/FM) and the most common bandwidths range from 800 kHz to 10 MHz.

i. Although there is no NTIA sanctioned channeling plan in the band, the discrete distribution of frequency assignments occurs generally at every 5 MHz intervals starting at 1710 MHz.

j. The number of Space Ground Link Subsystem uplink assignments to support the tracking, telemetry, and control of DOD orbiting satellites has increased 36% from December 1978 to March 1990.

k. The 1710-1850 MHz is the predominant band used by the Army for command and control employing an area-wide grid network system. Typically, there are over 200 communication links for an area network system. The frequency assignments supporting these links are not recorded in the GMF.

APPENDIX C
SPECTRUM USE MEASURE

INTRODUCTION

The Spectrum Use Measure (SUM) model[29] develops data that represents the extent of use of a radio frequency band. The data contain spectrum use values for test points spaced at even intervals of latitude and longitude throughout the geographic area of interest. Frequency assignments from the Government Master File (GMF) of frequency assignments provide the basic input data on existing systems. Automated calculations are performed for test points in the vicinity of each existing transmitter and receiver, resulting in the SUM data base. The data can then be presented in the form of maps, histograms and/or indices describing the extent of use of the frequency band.

The use of part of a frequency band at a test point by existing systems means that that part of the frequency band is unavailable for a hypothetical new system (called the reference system) at that location. Frequencies are made unavailable because of the potential for interference either from existing transmitters to the reference receiver or from the reference transmitter to existing receivers. The extent of spectrum use at a test point is dependent upon both the existing systems and the characteristics of the reference system.

Spectrum-area used for any one transmitter-receiver pair is the union of spectral bandwidth and geographical area in which the authorized transmitter-receiver system would either 1) cause the carrier signal-to-interference (C/I) ratio of a hypothetical reference receiver to be less than a certain value, or 2) suffer a reduction of its C/I ratio below a certain value due to a hypothetical reference transmitter. The hypothetical transmitter-receiver combination is termed the reference system, and has technical parameters corresponding to systems operating in a specified service. The reference system represents a new system, which, for analysis purposes, is assumed to operate at various geographic locations.

The reference system has assumed technical parameters of e.i.r.p., emission bandwidth, and receiver intermediate frequency (IF) bandwidth that are the median values for all the sytems authorized in the frequency band of interest. To analyze the potential for accommodating the reference system in the electromagnetic environment, this reference system is analytically moved among a series of test points in the vicinity of the authorized system to evaluate the impact caused to it and to the authorized system. The test points are contained in a box (rectangular for fixed systems, circular for mobile systems) and are the focus of points enclosing the geographical limits of potential interference, based on the parameters of the systems. The test points are spaced at specified increments (e.g., 5 minutes in latitude and longitude).

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29 Mayher, Robert J., et al.

Those geographical locations, as represented by the test points and at which the authorized system or the reference system suffer a reduction in the received C/I ratio, are considered to be locations used by the authorized system over its interference bandwidth. The reference system is then stepped through all the test points in the box and the data regarding the potential interference is saved in an array. This procedure is repeated for each authorized system in the frequency band and area of interest. The data from all authorized systems is aggregated for each test point. This data forms the basic SUM data base.

The SUM data can be contoured to show the amount of spectrum in the frequency band of interest that is used in any location. The spectrum used is aggregated and displayed as contours. For example, a contour with a value of 150 MHz would enclose an area where all locations "used" 150 MHz of the frequency band.

CALCULATION OF SPECTRUM USE

A location is "used" by the assigned systems in a certain frequency band if, hypothetically, the reference station at that location would either cause unacceptable interference to one or more assigned systems or experience unacceptable interference from one or more assigned systems. The criterion for unacceptable interference is the ratio of received carrier power to interference power (C/I ratio): if the C/I ratio at the receiver is less than the threshold value (C/I_{th}), an unacceptable interference condition is assumed.

The carrier power at a receiver from the associated transmitter is:

$$C = P_D + G_D(0) + G_R(0) - L_{FS}(d_D) \qquad (1)$$

where:

C	=	Desired carrier power at the receiver, in dBW
P_D	=	Power of the desired transmitter, in dBW
$G_D(0)$	=	Mainbeam gain of the desired transmitter antenna, in dBi
$G_R(0)$	=	Mainbeam gain of the receiver antenna, in dBi
d_D	=	Distance between the desired transmitter and the receiver, in km
$L_{FS}(d_D)$	=	Free space loss associated with the distance d_D, in dB

The transmitter power and the antenna gains are provided in the GMF records. The distance between the transmitter and the receiver can also be determined from GMF data. In this way, the desired carrier power can be determined for a link.

The power at the receiver from an interfering transmitter is:

$$I = P_I + G_I(\Theta_I) + G_R(\Theta_R) - L_P(d_I) - FDR \qquad (2)$$

where:

I = Interference power at the receiver, in dBW

P_I = Power of the interfering transmitter, in dBW

Θ_I = Angle at the interfering transmitter between the direction to the receiver and the mainbeam direction, in degrees

$G_I(\Theta_I)$ = Gain of the interfering transmitter antenna $\Theta_I{}^\circ$ off the mainbeam, in dBi

Θ_R = Angle at the receiver between the direction to the interfering transmitter and the mainbeam direction, in degrees

$G_R(\Theta_R)$ = Gain of the receiver antenna $\Theta_R{}^\circ$ off the mainbeam, in dBi

d_I = Distance between the interfering transmitter and the receiver, in km

$L_P(d_I)$ = Propagation path loss associated with the distance d_I, in dB

FDR = Frequency dependent rejection of the interfering signal by the receiver IF filter, in dB

Spectrum Use Bandwidth. The spectrum use bandwidth (SUB) at a test point, the total bandwidth used at that test point by assigned systems, is determined using Equation 3:

$$SUB = \begin{cases} BW_{int} & \text{if } L_I < L_{Ith} \\ 0 & \text{otherwise} \end{cases} \qquad (3)$$

where:

SUB = Spectrum use bandwidth at the test point, in MHz

BW_{int} = Bandwidth over which interference will occur, in MHz

The data required to make a very basic model of the assigned system is provided in the GMF. This data generally includes transmitter and receiver locations and elevations, transmitter power and bandwidth and transmitter and receiver antenna gains and antenna heights. The desired carrier power can then be computed at each receiver (there may be more than one receiver associated with a transmitter) using Equation 1 above.

For the reference system, the transmitter power and bandwidth, the antenna gains, the effective antenna heights and the desired carrier power at the receiver are set to the median values for the fixed service assignments in the band being analyzed. The user may choose other values for the reference systems.

For this study, the following reference system parameters were used:

Type of Service	Fixed
Transmitter power	5 Watts
Antenna gain	0 dBi (est. sidelobe gain)
Bandwidth	5 MHz
Median received power	-65 dBW
Test points	5 minute intervals

The FDR term in Equation 2 is calculated using Equation 4:

$$\begin{aligned} FDR &= 10\log(BW_I/BW_R) \quad \text{if } BW_I > BW_R \\ &= 0 \quad \text{otherwise} \end{aligned} \tag{4}$$

where:

BW_I = Bandwidth of the interfering signal, in MHz

BW_R = IF bandwidth of the desired receiver, in MHz

The necessary bandwidths listed in the GMF are used for the assigned systems and for determining the median value for the reference system.

The C/I protection ratio used in the model are: 60 dB for co-channel interference and 0 dB for adjacent-channel interference (corresponding to 60 dB off-frequency rejection in the adjacent channel).

BW_{int} (from Equation 3) is the bandwidth over which co-channel or adjacent-channel interference occurs. For co-channel interference, BW_{int} is assumed to be the sum of the assigned and reference system necessary bandwidths. For adjacent-channel interference BW_{int} is assumed to be three times the co-channel interference bandwidth.

Propagation Loss. The propagation loss between a transmitter and a receiver is a function of the distance between them. For determination of the desired carrier power, the propagation loss is based on the distance between the transmitter and the receiver of the assigned system. For determination of the desired carrier power, free space loss is used. This is appropriate, except for transhorizon systems. Using free space loss, the desired carrier power calculated at the receiver of a transhorizon system will be unreasonably large, resulting in excessively small use areas for transmitters.

The Integrated Propagation System (IPS) model is used to determine the propagation loss for interference paths. This model includes diffraction and transhorizon modes as well as the free space mode. The model chooses the appropriate mode based on the path length and the antenna heights.

When using a smooth-earth model like the IPS, an effective antenna height is used for the transmitter and receiver stations. The effective antenna height is the difference between the height of the antenna above mean sea level (the sum of the site elevation and the height of the antenna above the ground) and the average elevation of several points in the direction of propagation. Since the use of detailed elevation data is not practical when large areas are being analyzed, a simpler method of determining the average elevation in the vicinity of a site was needed. A file containing average elevation values for points every fifteen minutes of latitude and longitude was used. The average elevation values were calculated by averaging 30" data within a 25 km radius of the center point. To determine the effective antenna height for an assigned station, the antenna height was added to the difference between the elevation given in the GMF and the average elevation (but not less than zero). For the reference station, the median antenna height alone was used since the test point site was assumed to be at the average elevation.

The user enters a value for the elevation above mean sea level of all airborne stations. The default value is 15,000 ft. The average elevation is subtracted from this value to obtain the effective antenna height.

Antenna Radiation Patterns. CCIR Report 614-2[30] provides reference antenna patterns for radio-relay systems. The basic pattern is:

$$G(\phi) = 52 - 10\log(D/L) - 25\log(\phi) \qquad (5)$$

where:

$G(\phi)$ = Gain of the antenna ϕ degrees off the mainbeam, in dBi

D = Diameter of the parabolic reflector

L = Wavelength of the carrier

When the reflector diameter is not known, CCIR Report 391-5, Annex I[31] suggests the following estimate be used:

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30 CCIR, Reference Radiation Patterns for Radio-Relay System Antennas, Report 614-2, Volume IX - Part I, International Telecommunication Union, Geneva, Switzerland, 1986, pp 270-274.

31 CCIR, Radiation Diagrams of Antennas for Earth Stations in the Fixed-Satellite Service for Use in Interference Studies and for the Determination of a Design Objective, Report 391-5, Volume IV - Part I, International Telecommunication Union, Geneva, Switzerland, 1986, pp 138-156.

$$20\log(D/L) \approx G_{max} - 7.7 \quad (6)$$

where:

G_{max} = Mainbeam gain of the antenna, in dBi

In the vicinity of the mainbeam, Report 391-5 suggests the following:

$$G(\phi) = G_{max} - .0025[(D/L)\phi]^2 \quad (7)$$

Between the curves of Equations 7 and 5, Report 391-5 suggests a constant value for the first sidelobe gain:

$$G_1 = 2 + 15\log(D/L) \quad (8)$$

where:

G_1 = Gain of the first sidelobe, in dBi

For frequency re-use problems assuming parallel polarization, CCIR Report 614-2 recommends 0 dBi residual gain up to 90° and -15 dBi residual gain between 90° and 180°. This means that Equation 5 is used for angles ϕ up to the point where $G(\phi) = 0$ dBi. A constant value of 0 dBi is then used for $G(\phi)$ up to 90°. Beyond 90°, $G(\phi) = -15$ dBi.

This model is used for all antennas having a mainbeam gain greater than 10 dBi. For antennas having a smaller mainbeam gain, the gain is assumed to be constant in all directions.

APPENDIX D
ADDITIONAL DISCUSSION ON RELIABILITY

This appendix contains a series of microwave reliability calculations based on atmospheric multipath for 2 and 6 GHz links under a variety of conditions. Typical equipment parameters are used in the calculations. The calculations were based on a standard method for calculation developed at Bell Telephone Laboratory in 1975.[30] These calculations do not take into account the effects of atmospheric ducting.

Eight key parameters should be noted in these calculations. The frequency in GHz is indicated near the top of each calculation sheet. Results are presented alternatively for 2 GHz and 6 GHz for same conditions. The indicated path length were used over various distances up to 50 miles. The indicated antenna size was selected so that adequate reliability could be achieved. The calculations were performed for a variety of radio equipment types including digital and analog. Two different terrain/climate factors were used based on Figure 4-3 in the text, with a value of 6 representing a very difficult propagation area and 0.25 representing an ideal propagation area. The final key parameters are the calculated non-diversity outage time and space diversity outage time in seconds per year. The final key parameter Bell short haul objective is a design objective for outage that varies with path length.

The following table summarizes the results with a key to indicate the page number of the detailed calculation. For all of the cases studied here, the reliability of the 2 and 6 GHz band were comparable.

TABLE D-1
COMPARISON OF RELIABILITY RESULTS FOR VARIOUS CONDITIONS

PAGE NO.	BAND GHz	PATH LENG. MILES	MODULATION	ANT. SIZE FEET	RADIO PROPAGATION AREA	DIVERSITY REQUIRED	OUTAGE TIME SEC.	OBJECTIVE SECONDS
D-2	2	15	96 CHAN DIGITAL	8	VERY DIFFICULT	NO	39	96
D-3	6	15	96 CHAN DIGITAL	8	VERY DIFFICULT	NO	35	96
D-4	2	25	96 CHAN DIGITAL	12	VERY DIFFICULT	NO	114	160
D-5	6	25	96 CHAN DIGITAL	12	VERY DIFFICULT	NO	160	160
D-6	2	35	96 CHAN DIGITAL	8	VERY DIFFICULT	YES	122	224
D-7	6	35	96 CHAN DIGITAL	8	VERY DIFFICULT	YES	7	224
D-8	2	15	672 CHAN DIGITAL	8	VERY DIFFICULT	YES	45	96
D-9	6	15	672 CHAN DIGITAL	8	VERY DIFFICULT	YES	2	96
D-10	2	25	672 CHAN DIGITAL	12	VERY DIFFICULT	YES	118	160
D-11	6	25	672 CHAN DIGITAL	8	VERY DIFFICULT	YES	129	160
D-12	2	30	672 CHAN DIGITAL	12	VERY DIFFICULT	YES	1282*	192
D-13	6	30	672 CHAN DIGITAL	12	VERY DIFFICULT	YES	95	192
D-14	2	30	600 CHAN ANALOG	8	IDEAL	NO	45	192
D-15	6	30	600 CHAN ANALOG	8	IDEAL	NO	10	192
D-16	2	50	600 CHAN ANALOG	10	IDEAL	NO	163	320
D-17	6	50	600 CHAN ANALOG	10	IDEAL	NO	50	320

* CANNOT ACHIEVE OUTAGE OBJECTIVE

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NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION
US DEPARTMENT of COMMERCE
MICROWAVE RADIO PATH CALCULATION SPREADSHEET 30-Jul-92

PROJECT NAME -- ?
ENGINEER -- ?
FREQUENCY (GHz) -- 1.90

1. SITE NAME		?		?
3. LATITUDE, North,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
4. LONGITUDE, West,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
5. SITE ELEVATION, AMSL	Feet	?		?
6. AZIMUTH FROM NORTH	Degrees	0.0		0.0
7. PATH LENGTH	Miles		15.0	
8. PATH ATTENUATION	dB		125.7	
10. TOWER TYPE		?		?
11. ANTENNA HEIGHT,AGL	Feet	130		130
12. TRANSMISSION LINE LENGTH	Feet	140		140
13. TRANS. LINE TYPE		7/8" FOAM		7/8" FOAM
14. TRANS. LINE LOSS	dB/100'	2.00		2.00
15. TRANSMISSION LINE LOSS	dB	2.8		2.8
16. MISCELLANEOUS LOSSES	dB	0.5		0.5
17. PROTECTED TERMINAL LOSS	dB	?		?
18. DIVERSITY RECEPTION LOSS	dB	?		?
19. TOTAL FIXED LOSSES	dB	3.3		3.3
20. TOTAL LOSSES(PATH AND FIXED)	dB		132.3	
21. ANTENNA DIAMETER	Feet	8.0		8.0
22. ANTENNA TYPE		GRID		GRID
23. ANTENNA GAIN	dBi	31.3		31.3
24. TOTAL ANTENNA GAINS	dB		62.7	
25. NET SYSTEM LOSS	dB		69.6	
26. RADIO EQUIPMENT TYPE AND CAPACITY			DIGITAL 96	
27. MINIMUM TRANSMITTER POWER	dBm		32.0	
28. RECEIVER THRESHOLD	dBm		-83.0	
29. NET SYSTEM GAIN	dB		115.0	
30. MEDIAN RECEIVED POWER	dBm		-37.6	
30. FLAT FADE MARGIN	dB		45.4	
31. DISPERSIVE F.M. (DIG. ONLY)	dB		51.0	
32. COMPOSITE FADE MARGIN	dB		44.3	

WEIGHTED RAYLEIGH PROPAGATION RELIABILITY FOR ATMOSPHERIC MULTIPATH

TERRAIN/CLIMATE FACTOR	0.25 TO 6			6.0
MEAN ANNUAL TEMPERATURE	Deg F			68.0
DIVERSITY SPACING	Feet			60.0
NON-DIVERSITY OUTAGE TIME	Sec/yr			38.8
NON-DIVERSITY AVAILABILITY	Percent			99.99988
SPACE DIVERSITY IMPROV. FACTOR	Decimal			864.2
SPACE DIVERSITY OUTAGE TIME	Sec/yr			0.0
SPACE DIVERSITY AVAILABILITY	Percent			100.00000
BELL SHORT HAUL OBJECTIVE	Sec/yr			96.0

NOTE: FOR CALCULATION METHOD OF RELIABILITY REFER TO A. VIGANTS, SPACE DIVERSITY ENGINEERING, BSTJ, VOL. 54, NO. 1, JAN 1975

NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION
US DEPARTMENT of COMMERCE
MICROWAVE RADIO PATH CALCULATION SPREADSHEET 30-Jul-92

PROJECT NAME		?		
ENGINEER		?		
FREQUENCY (GHz)		6.70		
1. SITE NAME		?		?
3. LATITUDE, North,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
4. LONGITUDE, West,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
5. SITE ELEVATION, AMSL	Feet	?		?
6. AZIMUTH FROM NORTH	Degrees	0.0		0.0
7. PATH LENGTH	Miles		15.0	
8. PATH ATTENUATION	dB		136.6	
10. TOWER TYPE		?		?
11. ANTENNA HEIGHT,AGL	Feet	130		130
12. TRANSMISSION LINE LENGTH	Feet	140		140
13. TRANS. LINE TYPE		EW63		EW63
14. TRANS. LINE LOSS	dB/100'	1.40		1.40
15. TRANSMISSION LINE LOSS	dB	2.0		2.0
16. MISCELLANEOUS LOSSES	dB	0.5		0.5
17. PROTECTED TERMINAL LOSS	dB	?		?
18. DIVERSITY RECEPTION LOSS	dB	?		?
19. TOTAL FIXED LOSSES	dB	2.5		2.5
20. TOTAL LOSSES(PATH AND FIXED)	dB		141.6	
21. ANTENNA DIAMETER	Feet	8.0		8.0
22. ANTENNA TYPE		SOLID		SOLID
23. ANTENNA GAIN	dBi	42.3		42.3
24. TOTAL ANTENNA GAINS	dB		84.6	
25. NET SYSTEM LOSS	dB		57.0	
26. RADIO EQUIPMENT TYPE AND CAPACITY			DIGITAL 96	
27. MINIMUM TRANSMITTER POWER	dBm		32.0	
28. RECEIVER THRESHOLD	dBm		-83.0	
29. NET SYSTEM GAIN	dB		115.0	
30. MEDIAN RECEIVED POWER	dBm		-25.0	
30. FLAT FADE MARGIN	dB		58.0	
31. DISPERSIVE F.M. (DIG. ONLY)	dB		51.0	
32. COMPOSITE FADE MARGIN	dB		50.2	

WEIGHTED RAYLEIGH PROPAGATION RELIABILITY FOR ATMOSPHERIC MULTIPATH

TERRAIN/CLIMATE FACTOR	0.25 TO 6			6.0
MEAN ANNUAL TEMPERATURE	Deg F			68.0
DIVERSITY SPACING	Feet			30.0
NON-DIVERSITY OUTAGE TIME	Sec/yr			35.3
NON-DIVERSITY AVAILABILITY	Percent			99.99989
SPACE DIVERSITY IMPROV. FACTOR	Decimal			2953.7
SPACE DIVERSITY OUTAGE TIME	Sec/yr			0.0
SPACE DIVERSITY AVAILABILITY	Percent			100.00000
BELL SHORT HAUL OBJECTIVE	Sec/yr			96.0

NOTE: FOR CALCULATION METHOD OF RELIABILITY REFER TO A. VIGANTS, SPACE DIVERSITY ENGINEERING, BSTJ, VOL. 54, NO. 1, JAN 1975

NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION
US DEPARTMENT of COMMERCE
MICROWAVE RADIO PATH CALCULATION SPREADSHEET 30-Jul-92

PROJECT NAME ---------- ?
ENGINEER ---------- ?
FREQUENCY (GHz) ---------- 1.90

1. SITE NAME		?		?
3. LATITUDE, North,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
4. LONGITUDE, West,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
5. SITE ELEVATION, AMSL	Feet	?		?
6. AZIMUTH FROM NORTH	Degrees	0.0		0.0
7. PATH LENGTH	Miles		25.0	
8. PATH ATTENUATION	dB		130.1	
10. TOWER TYPE		?		?
11. ANTENNA HEIGHT,AGL	Feet	210		210
12. TRANSMISSION LINE LENGTH	Feet	220		220
13. TRANS. LINE TYPE		1 5/8" FOAM		1 5/8" FOAM
14. TRANS. LINE LOSS	dB/100'	1.25		1.25
15. TRANSMISSION LINE LOSS	dB	2.8		2.8
16. MISCELLANEOUS LOSSES	dB	0.5		0.5
17. PROTECTED TERMINAL LOSS	dB	?		?
18. DIVERSITY RECEPTION LOSS	dB	?		?
19. TOTAL FIXED LOSSES	dB	3.3		3.3
20. TOTAL LOSSES(PATH AND FIXED)	dB		136.6	
21. ANTENNA DIAMETER	Feet	12.0		12.0
22. ANTENNA TYPE		GRID		GRID
23. ANTENNA GAIN	dBi	34.9		34.9
24. TOTAL ANTENNA GAINS	dB		69.7	
25. NET SYSTEM LOSS	dB		66.9	
26. RADIO EQUIPMENT TYPE AND CAPACITY			DIGITAL 96	
27. MINIMUM TRANSMITTER POWER	dBm		32.0	
28. RECEIVER THRESHOLD	dBm		-83.0	
29. NET SYSTEM GAIN	dB		115.0	
30. MEDIAN RECEIVED POWER	dBm		-34.9	
30. FLAT FADE MARGIN	dB		48.1	
31. DISPERSIVE F.M. (DIG. ONLY)	dB		51.0	
32. COMPOSITE FADE MARGIN	dB		46.3	

WEIGHTED RAYLEIGH PROPAGATION RELIABILITY FOR ATMOSPHERIC MULTIPATH

TERRAIN/CLIMATE FACTOR	0.25 TO 6			6.0
MEAN ANNUAL TEMPERATURE	Deg F			68.0
DIVERSITY SPACING	Feet			60.0
NON-DIVERSITY OUTAGE TIME	Sec/yr			114.4
NON-DIVERSITY AVAILABILITY	Percent			99.99964
SPACE DIVERSITY IMPROV. FACTOR	Decimal			815.3
SPACE DIVERSITY OUTAGE TIME	Sec/yr			0.1
SPACE DIVERSITY AVAILABILITY	Percent			100.00000
BELL SHORT HAUL OBJECTIVE	Sec/yr			160.0

NOTE: FOR CALCULATION METHOD OF RELIABILITY REFER TO A. VIGANTS, SPACE DIVERSITY ENGINEERING, BSTJ, VOL. 54, NO. 1, JAN 1975

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US DEPARTMENT of COMMERCE
MICROWAVE RADIO PATH CALCULATION SPREADSHEET 30-Jul-92

PROJECT NAME -- ?
ENGINEER -- ?
FREQUENCY (GHz) -- 6.70

1. SITE NAME		?		?
3. LATITUDE, North,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
4. LONGITUDE, West,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
5. SITE ELEVATION, AMSL	Feet	?		?
6. AZIMUTH FROM NORTH	Degrees	0.0		0.0
7. PATH LENGTH	Miles		25.0	
8. PATH ATTENUATION	dB		141.1	
10. TOWER TYPE		?		?
11. ANTENNA HEIGHT,AGL	Feet	210		210
12. TRANSMISSION LINE LENGTH	Feet	220		220
13. TRANS. LINE TYPE		EW63		EW63
14. TRANS. LINE LOSS	dB/100'	1.40		1.40
15. TRANSMISSION LINE LOSS	dB	3.1		3.1
16. MISCELLANEOUS LOSSES	dB	0.5		0.5
17. PROTECTED TERMINAL LOSS	dB	?		?
18. DIVERSITY RECEPTION LOSS	dB	?		?
19. TOTAL FIXED LOSSES	dB	3.6		3.6
20. TOTAL LOSSES(PATH AND FIXED)	dB		148.2	
21. ANTENNA DIAMETER	Feet	12.0		12.0
22. ANTENNA TYPE		SOLID		SOLID
23. ANTENNA GAIN	dBi	45.8		45.8
24. TOTAL ANTENNA GAINS	dB		91.6	
25. NET SYSTEM LOSS	dB		56.6	
26. RADIO EQUIPMENT TYPE AND CAPACITY			DIGITAL 96	
27. MINIMUM TRANSMITTER POWER	dBm		32.0	
28. RECEIVER THRESHOLD	dBm		-83.0	
29. NET SYSTEM GAIN	dB		115.0	
30. MEDIAN RECEIVED POWER	dBm		-24.6	
30. FLAT FADE MARGIN	dB		58.4	
31. DISPERSIVE F.M. (DIG. ONLY)	dB		51.0	
32. COMPOSITE FADE MARGIN	dB		50.3	

WEIGHTED RAYLEIGH PROPAGATION RELIABILITY FOR ATMOSPHERIC MULTIPATH

TERRAIN/CLIMATE FACTOR	0.25 TO 6			6.00
MEAN ANNUAL TEMPERATURE	Deg F			68.0
DIVERSITY SPACING	Feet			30.0
NON-DIVERSITY OUTAGE TIME	Sec/yr			160.0
NON-DIVERSITY AVAILABILITY	Percent			99.99949
SPACE DIVERSITY IMPROV. FACTOR	Decimal			1796.4
SPACE DIVERSITY OUTAGE TIME	Sec/yr			0.1
SPACE DIVERSITY AVAILABILITY	Percent			100.00000
BELL SHORT HAUL OBJECTIVE	Sec/yr			160.0

NOTE: FOR CALCULATION METHOD OF RELIABILITY REFER TO A. VIGANTS, SPACE DIVERSITY ENGINEERING, BSTJ, VOL 54, NO. 1, JAN 1975

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MICROWAVE RADIO PATH CALCULATION SPREADSHEET 30-Jul-92

PROJECT NAME	?
ENGINEER	?
FREQUENCY (GHz)	1.90

1. SITE NAME		?		?
3. LATITUDE, North,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
4. LONGITUDE, West,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
5. SITE ELEVATION, AMSL	Feet	?		?
6. AZIMUTH FROM NORTH	Degrees	0.0		0.0
7. PATH LENGTH	Miles		35.0	
8. PATH ATTENUATION	dB		133.1	
10. TOWER TYPE		?		?
11. ANTENNA HEIGHT,AGL	Feet	350		350
12. TRANSMISSION LINE LENGTH	Feet	360		360
13. TRANS. LINE TYPE		1 5/8" FOAM		1 5/8" FOAM
14. TRANS. LINE LOSS	dB/100'	1.25		1.25
15. TRANSMISSION LINE LOSS	dB	4.5		4.5
16. MISCELLANEOUS LOSSES	dB	0.5		0.5
17. PROTECTED TERMINAL LOSS	dB	?		?
18. DIVERSITY RECEPTION LOSS	dB	?		?
19. TOTAL FIXED LOSSES	dB	5.0		5.0
20. TOTAL LOSSES(PATH AND FIXED)	dB		143.1	
21. ANTENNA DIAMETER	Feet	8.0		8.0
22. ANTENNA TYPE		GRID		GRID
23. ANTENNA GAIN	dBi	31.3		31.3
24. TOTAL ANTENNA GAINS	dB		62.7	
25. NET SYSTEM LOSS	dB		80.4	
26. RADIO EQUIPMENT TYPE AND CAPACITY			DIGITAL 96	
27. MINIMUM TRANSMITTER POWER	dBm		32.0	
28. RECEIVER THRESHOLD	dBm		-83.0	
29. NET SYSTEM GAIN	dB		115.0	
30. MEDIAN RECEIVED POWER	dBm		-48.4	
30. FLAT FADE MARGIN	dB		34.6	
31. DISPERSIVE F.M. (DIG. ONLY)	dB		51.0	
32. COMPOSITE FADE MARGIN	dB		34.5	

WEIGHTED RAYLEIGH PROPAGATION RELIABILITY FOR ATMOSPHERIC MULTIPATH

TERRAIN/CLIMATE FACTOR	0.25 TO 6			6.0
MEAN ANNUAL TEMPERATURE	Deg F			68.0
DIVERSITY SPACING	Feet			60.0
NON-DIVERSITY OUTAGE TIME	Sec/yr			4720.5
NON-DIVERSITY AVAILABILITY	Percent			99.98503
SPACE DIVERSITY IMPROV. FACTOR	Decimal			38.7
SPACE DIVERSITY OUTAGE TIME	Sec/yr			121.9
SPACE DIVERSITY AVAILABILITY	Percent			99.99961
BELL SHORT HAUL OBJECTIVE	Sec/yr			224.0

NOTE: FOR CALCULATION METHOD OF RELIABILITY REFER TO A. VIGANTS,
SPACE DIVERSITY ENGINEERING, BSTJ, VOL. 54, NO. 1, JAN 1975

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MICROWAVE RADIO PATH CALCULATION SPREADSHEET 30-Jul-92

PROJECT NAME	?
ENGINEER	?
FREQUENCY (GHz)	6.70

1. SITE NAME		?		?
3. LATITUDE, North,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
4. LONGITUDE, West,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
5. SITE ELEVATION, AMSL	Feet	?		?
6. AZIMUTH FROM NORTH	Degrees	0.0		0.0
7. PATH LENGTH	Miles		35.0	
8. PATH ATTENUATION	dB		144.0	
10. TOWER TYPE		?		?
11. ANTENNA HEIGHT,AGL	Feet	350		350
12. TRANSMISSION LINE LENGTH	Feet	360		360
13. TRANS. LINE TYPE		EW63		EW63
14. TRANS. LINE LOSS	dB/100'	1.40		1.40
15. TRANSMISSION LINE LOSS	dB	5.0		5.0
16. MISCELLANEOUS LOSSES	dB	0.5		0.5
17. PROTECTED TERMINAL LOSS	dB	?		?
18. DIVERSITY RECEPTION LOSS	dB	?		?
19. TOTAL FIXED LOSSES	dB	5.5		5.5
20. TOTAL LOSSES(PATH AND FIXED)	dB		155.1	
21. ANTENNA DIAMETER	Feet	8.0		8.0
22. ANTENNA TYPE		SOLID		SOLID
23. ANTENNA GAIN	dBi	42.3		42.3
24. TOTAL ANTENNA GAINS	dB		84.6	
25. NET SYSTEM LOSS	dB		70.5	
26. RADIO EQUIPMENT TYPE AND CAPACITY			DIGITAL 96	
27. MINIMUM TRANSMITTER POWER	dBm		32.0	
28. RECEIVER THRESHOLD	dBm		-83.0	
29. NET SYSTEM GAIN	dB		115.0	
30. MEDIAN RECEIVED POWER	dBm		-38.5	
30. FLAT FADE MARGIN	dB		44.5	
31. DISPERSIVE F.M. (DIG. ONLY)	dB		51.0	
32. COMPOSITE FADE MARGIN	dB		43.6	

WEIGHTED RAYLEIGH PROPAGATION RELIABILITY FOR ATMOSPHERIC MULTIPATH

TERRAIN/CLIMATE FACTOR	0.25 TO 6			6.0
MEAN ANNUAL TEMPERATURE	Deg F			68.0
DIVERSITY SPACING	Feet			30.0
NON-DIVERSITY OUTAGE TIME	Sec/yr			2052.3
NON-DIVERSITY AVAILABILITY	Percent			99.99349
SPACE DIVERSITY IMPROV. FACTOR	Decimal			276.9
SPACE DIVERSITY OUTAGE TIME	Sec/yr			7.4
SPACE DIVERSITY AVAILABILITY	Percent			99.99998
BELL SHORT HAUL OBJECTIVE	Sec/yr			224.0

NOTE: FOR CALCULATION METHOD OF RELIABILITY REFER TO A. VIGANTS, SPACE DIVERSITY ENGINEERING, BSTJ, VOL. 54, NO. 1, JAN 1975

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US DEPARTMENT of COMMERCE
MICROWAVE RADIO PATH CALCULATION SPREADSHEET 30-Jul-92

PROJECT NAME		?		
ENGINEER		?		
FREQUENCY (GHz)		1.90		
1. SITE NAME		?		?
3. LATITUDE, North,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
4. LONGITUDE, West,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
5. SITE ELEVATION, AMSL	Feet	?		?
6. AZIMUTH FROM NORTH	Degrees	0.0		0.0
7. PATH LENGTH	Miles		15.0	
8. PATH ATTENUATION	dB		125.7	
10. TOWER TYPE		?		?
11. ANTENNA HEIGHT,AGL	Feet	130		130
12. TRANSMISSION LINE LENGTH	Feet	140		140
13. TRANS. LINE TYPE		7/8" FOAM		7/8" FOAM
14. TRANS. LINE LOSS	dB/100'	2.00		2.00
15. TRANSMISSION LINE LOSS	dB	2.8		2.8
16. MISCELLANEOUS LOSSES	dB	0.5		0.5
17. PROTECTED TERMINAL LOSS	dB	?		?
18. DIVERSITY RECEPTION LOSS	dB	?		?
19. TOTAL FIXED LOSSES	dB	3.3		3.3
20. TOTAL LOSSES(PATH AND FIXED)	dB		132.3	
21. ANTENNA DIAMETER	Feet	8.0		8.0
22. ANTENNA TYPE		GRID		GRID
23. ANTENNA GAIN	dBi	31.3		31.3
24. TOTAL ANTENNA GAINS	dB		62.7	
25. NET SYSTEM LOSS	dB		69.6	
26. RADIO EQUIPMENT TYPE AND CAPACITY			DIGITAL 672	
27. MINIMUM TRANSMITTER POWER	dBm		30.0	
28. RECEIVER THRESHOLD	dBm		-69.0	
29. NET SYSTEM GAIN	dB		99.0	
30. MEDIAN RECEIVED POWER	dBm		-39.6	
30. FLAT FADE MARGIN	dB		29.4	
31. DISPERSIVE F.M. (DIG. ONLY)	dB		51.0	
32. COMPOSITE FADE MARGIN	dB		29.3	

WEIGHTED RAYLEIGH PROPAGATION RELIABILITY FOR ATMOSPHERIC MULTIPATH

TERRAIN/CLIMATE FACTOR	0.25 TO 6			6.0
MEAN ANNUAL TEMPERATURE	Deg F			68.0
DIVERSITY SPACING	Feet			60.0
NON-DIVERSITY OUTAGE TIME	Sec/yr			1222.4
NON-DIVERSITY AVAILABILITY	Percent			99.99612
SPACE DIVERSITY IMPROV. FACTOR	Decimal			27.5
SPACE DIVERSITY OUTAGE TIME	Sec/yr			44.5
SPACE DIVERSITY AVAILABILITY	Percent			99.99986
BELL SHORT HAUL OBJECTIVE	Sec/yr			96.0

NOTE: FOR CALCULATION METHOD OF RELIABILITY REFER TO A. VIGANTS, SPACE DIVERSITY ENGINEERING, BSTJ, VOL. 54, NO. 1, JAN 1975

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MICROWAVE RADIO PATH CALCULATION SPREADSHEET 30-Jul-92

PROJECT NAME		?		
ENGINEER		?		
FREQUENCY (GHz)		6.70		
1. SITE NAME		?		?
3. LATITUDE, North,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
4. LONGITUDE, West,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
5. SITE ELEVATION, AMSL	Feet	?		?
6. AZIMUTH FROM NORTH	Degrees	0.0		0.0
7. PATH LENGTH	Miles		15.0	
8. PATH ATTENUATION	dB		136.6	
10. TOWER TYPE		?		?
11. ANTENNA HEIGHT,AGL	Feet	130		130
12. TRANSMISSION LINE LENGTH	Feet	140		140
13. TRANS. LINE TYPE		EW63		EW63
14. TRANS. LINE LOSS	dB/100'	1.40		1.40
15. TRANSMISSION LINE LOSS	dB	2.0		2.0
16. MISCELLANEOUS LOSSES	dB	0.5		0.5
17. PROTECTED TERMINAL LOSS	dB	?		?
18. DIVERSITY RECEPTION LOSS	dB	?		?
19. TOTAL FIXED LOSSES	dB	2.5		2.5
20. TOTAL LOSSES(PATH AND FIXED)	dB		141.6	
21. ANTENNA DIAMETER	Feet	8.0		8.0
22. ANTENNA TYPE		SOLID		SOLID
23. ANTENNA GAIN	dBi	42.3		42.3
24. TOTAL ANTENNA GAINS	dB		84.6	
25. NET SYSTEM LOSS	dB		57.0	
26. RADIO EQUIPMENT TYPE AND CAPACITY			DIGITAL 672	
27. MINIMUM TRANSMITTER POWER	dBm		30.0	
28. RECEIVER THRESHOLD	dBm		-69.0	
29. NET SYSTEM GAIN	dB		99.0	
30. MEDIAN RECEIVED POWER	dBm		-27.0	
30. FLAT FADE MARGIN	dB		42.0	
31. DISPERSIVE F.M. (DIG. ONLY)	dB		42.0	
32. COMPOSITE FADE MARGIN	dB		39.0	

WEIGHTED RAYLEIGH PROPAGATION RELIABILITY FOR ATMOSPHERIC MULTIPATH

TERRAIN/CLIMATE FACTOR	0.25 TO 6			6.0
MEAN ANNUAL TEMPERATURE	Deg F			68.0
DIVERSITY SPACING	Feet			30.0
NON-DIVERSITY OUTAGE TIME	Sec/yr			467.8
NON-DIVERSITY AVAILABILITY	Percent			99.99852
SPACE DIVERSITY IMPROV. FACTOR	Decimal			223.1
SPACE DIVERSITY OUTAGE TIME	Sec/yr			2.1
SPACE DIVERSITY AVAILABILITY	Percent			99.99999
BELL SHORT HAUL OBJECTIVE	Sec/yr			96.0

NOTE: FOR CALCULATION METHOD OF RELIABILITY REFER TO A. VIGANTS, SPACE DIVERSITY ENGINEERING, BSTJ, VOL. 54, NO. 1, JAN 1975

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MICROWAVE RADIO PATH CALCULATION SPREADSHEET 30-Jul-92

PROJECT NAME		?		
ENGINEER		?		
FREQUENCY (GHz)		1.90		
1. SITE NAME		?		?
3. LATITUDE, North,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
4. LONGITUDE, West,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
5. SITE ELEVATION, AMSL	Feet	?		?
6. AZIMUTH FROM NORTH	Degrees	0.0		0.0
7. PATH LENGTH	Miles		25.0	
8. PATH ATTENUATION	dB		130.1	
10. TOWER TYPE		?		?
11. ANTENNA HEIGHT,AGL	Feet	210		210
12. TRANSMISSION LINE LENGTH	Feet	220		220
13. TRANS. LINE TYPE		1 5/8" FOAM		1 5/8" FOAM
14. TRANS. LINE LOSS	dB/100'	1.25		1.25
15. TRANSMISSION LINE LOSS	dB	2.8		2.8
16. MISCELLANEOUS LOSSES	dB	0.5		0.5
17. PROTECTED TERMINAL LOSS	dB	?		?
18. DIVERSITY RECEPTION LOSS	dB	?		?
19. TOTAL FIXED LOSSES	dB	3.3		3.3
20. TOTAL LOSSES(PATH AND FIXED)	dB		136.6	
21. ANTENNA DIAMETER	Feet	12.0		12.0
22. ANTENNA TYPE		GRID		GRID
23. ANTENNA GAIN	dBi	34.9		34.9
24. TOTAL ANTENNA GAINS	dB		69.7	
25. NET SYSTEM LOSS	dB		66.9	
26. RADIO EQUIPMENT TYPE AND CAPACITY			DIGITAL 672	
27. MINIMUM TRANSMITTER POWER	dBm		30.0	
28. RECEIVER THRESHOLD	dBm		-69.0	
29. NET SYSTEM GAIN	dB		99.0	
30. MEDIAN RECEIVED POWER	dBm		-36.9	
30. FLAT FADE MARGIN	dB		32.1	
31. DISPERSIVE F.M. (DIG. ONLY)	dB		42.0	
32. COMPOSITE FADE MARGIN	dB		31.7	
WEIGHTED RAYLEIGH PROPAGATION RELIABILITY FOR ATMOSPHERIC MULTIPATH				
TERRAIN/CLIMATE FACTOR	0.25 TO 6			6.0
MEAN ANNUAL TEMPERATURE	Deg F			68.0
DIVERSITY SPACING	Feet			60.0
NON-DIVERSITY OUTAGE TIME	Sec/yr			3321.0
NON-DIVERSITY AVAILABILITY	Percent			99.98947
SPACE DIVERSITY IMPROV. FACTOR	Decimal			28.1
SPACE DIVERSITY OUTAGE TIME	Sec/yr			118.3
SPACE DIVERSITY AVAILABILITY	Percent			99.99962
BELL SHORT HAUL OBJECTIVE	Sec/yr			160.0

NOTE: FOR CALCULATION METHOD OF RELIABILITY REFER TO A. VIGANTS, SPACE DIVERSITY ENGINEERING, BSTJ, VOL 54, NO. 1, JAN 1975

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MICROWAVE RADIO PATH CALCULATION SPREADSHEET 30-Jul-92

PROJECT NAME -- ?
ENGINEER -- ?
FREQUENCY (GHz) -- 6.70

1. SITE NAME		?		?
3. LATITUDE, North,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
4. LONGITUDE, West,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
5. SITE ELEVATION, AMSL	Feet	?		?
6. AZIMUTH FROM NORTH	Degrees	0.0		0.0
7. PATH LENGTH	Miles		25.0	
8. PATH ATTENUATION	dB		141.1	
10. TOWER TYPE		?		?
11. ANTENNA HEIGHT,AGL	Feet	210		210
12. TRANSMISSION LINE LENGTH	Feet	220		220
13. TRANS. LINE TYPE		EW63		EW63
14. TRANS. LINE LOSS	dB/100'	1.40		1.40
15. TRANSMISSION LINE LOSS	dB	3.1		3.1
16. MISCELLANEOUS LOSSES	dB	0.5		0.5
17. PROTECTED TERMINAL LOSS	dB	?		?
18. DIVERSITY RECEPTION LOSS	dB	?		?
19. TOTAL FIXED LOSSES	dB	3.6		3.6
20. TOTAL LOSSES(PATH AND FIXED)	dB		148.2	
21. ANTENNA DIAMETER	Feet	8.0		8.0
22. ANTENNA TYPE		SOLID		SOLID
23. ANTENNA GAIN	dBi	42.3		42.3
24. TOTAL ANTENNA GAINS	dB		84.6	
25. NET SYSTEM LOSS	dB		63.7	
26. RADIO EQUIPMENT TYPE AND CAPACITY			DIGITAL 672	
27. MINIMUM TRANSMITTER POWER	dBm		30.0	
28. RECEIVER THRESHOLD	dBm		-69.0	
29. NET SYSTEM GAIN	dB		99.0	
30. MEDIAN RECEIVED POWER	dBm		-33.7	
30. FLAT FADE MARGIN	dB		35.3	
31. DISPERSIVE F.M. (DIG. ONLY)	dB		42.0	
32. COMPOSITE FADE MARGIN	dB		34.5	

WEIGHTED RAYLEIGH PROPAGATION RELIABILITY FOR ATMOSPHERIC MULTIPATH

TERRAIN/CLIMATE FACTOR	0.25 TO 6			6.0
MEAN ANNUAL TEMPERATURE	Deg F			68.0
DIVERSITY SPACING	Feet			30.0
NON-DIVERSITY OUTAGE TIME	Sec/yr			6120.1
NON-DIVERSITY AVAILABILITY	Percent			99.98059
SPACE DIVERSITY IMPROV. FACTOR	Decimal			47.4
SPACE DIVERSITY OUTAGE TIME	Sec/yr			129.2
SPACE DIVERSITY AVAILABILITY	Percent			99.99959
BELL SHORT HAUL OBJECTIVE	Sec/yr			160.0

NOTE: FOR CALCULATION METHOD OF RELIABILITY REFER TO A. VIGANTS, SPACE DIVERSITY ENGINEERING, BSTJ, VOL. 54, NO. 1, JAN 1975

NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION
US DEPARTMENT of COMMERCE
MICROWAVE RADIO PATH CALCULATION SPREADSHEET 30-Jul-92

PROJECT NAME ---------- ?
ENGINEER ---------- ?
FREQUENCY (GHz) ---------- 1.90

1. SITE NAME		?		?
3. LATITUDE, North,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
4. LONGITUDE, West,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
5. SITE ELEVATION, AMSL	Feet	?		?
6. AZIMUTH FROM NORTH	Degrees	0.0		0.0
7. PATH LENGTH	Miles		30.0	
8. PATH ATTENUATION	dB		131.7	
10. TOWER TYPE		?		?
11. ANTENNA HEIGHT,AGL	Feet	300		300
12. TRANSMISSION LINE LENGTH	Feet	310		310
13. TRANS. LINE TYPE		1 5/8" FOAM		1 5/8" FOAM
14. TRANS. LINE LOSS	dB/100'	1.25		1.25
15. TRANSMISSION LINE LOSS	dB	3.9		3.9
16. MISCELLANEOUS LOSSES	dB	0.5		0.5
17. PROTECTED TERMINAL LOSS	dB	?		?
18. DIVERSITY RECEPTION LOSS	dB	?		?
19. TOTAL FIXED LOSSES	dB	4.4		4.4
20. TOTAL LOSSES(PATH AND FIXED)	dB		140.5	
21. ANTENNA DIAMETER	Feet	12.0		12.0
22. ANTENNA TYPE		GRID		GRID
23. ANTENNA GAIN	dBi	34.9		34.9
24. TOTAL ANTENNA GAINS	dB		69.7	
25. NET SYSTEM LOSS	dB		70.8	
26. RADIO EQUIPMENT TYPE AND CAPACITY			DIGITAL 672	
27. MINIMUM TRANSMITTER POWER	dBm		30.0	
28. RECEIVER THRESHOLD	dBm		-69.0	
29. NET SYSTEM GAIN	dB		99.0	
30. MEDIAN RECEIVED POWER	dBm		-40.8	
30. FLAT FADE MARGIN	dB		28.2	
31. DISPERSIVE F.M. (DIG. ONLY)	dB		42.0	
32. COMPOSITE FADE MARGIN	dB		28.1	

WEIGHTED RAYLEIGH PROPAGATION RELIABILITY FOR ATMOSPHERIC MULTIPATH

TERRAIN/CLIMATE FACTOR	0.25 TO 6			6.0
MEAN ANNUAL TEMPERATURE	Deg F			68.0
DIVERSITY SPACING	Feet			60.0
NON-DIVERSITY OUTAGE TIME	Sec/yr			13120.5
NON-DIVERSITY AVAILABILITY	Percent			99.95840
SPACE DIVERSITY IMPROV. FACTOR	Decimal			10.2
SPACE DIVERSITY OUTAGE TIME	Sec/yr			1281.9
SPACE DIVERSITY AVAILABILITY	Percent			99.99593
BELL SHORT HAUL OBJECTIVE	Sec/yr			192.0

NOTE: FOR CALCULATION METHOD OF RELIABILITY REFER TO A. VIGANTS, SPACE DIVERSITY ENGINEERING, BSTJ, VOL. 54, NO. 1, JAN 1975

NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION
US DEPARTMENT of COMMERCE
MICROWAVE RADIO PATH CALCULATION SPREADSHEET 30-Jul-92

PROJECT NAME ------------------------------		?		
ENGINEER ------------------------------		?		
FREQUENCY (GHz) ------------------------		6.70		
1. SITE NAME		?		?
3. LATITUDE, North,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
4. LONGITUDE, West,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
5. SITE ELEVATION, AMSL	Feet	?		?
6. AZIMUTH FROM NORTH	Degrees	0.0		0.0
7. PATH LENGTH	Miles		30.0	
8. PATH ATTENUATION	dB		142.7	
10. TOWER TYPE		?		?
11. ANTENNA HEIGHT,AGL	Feet	300		300
12. TRANSMISSION LINE LENGTH	Feet	310		310
13. TRANS. LINE TYPE		EW63		EW63
14. TRANS. LINE LOSS	dB/100'	1.40		1.40
15. TRANSMISSION LINE LOSS	dB	4.3		4.3
16. MISCELLANEOUS LOSSES	dB	0.5		0.5
17. PROTECTED TERMINAL LOSS	dB	?		?
18. DIVERSITY RECEPTION LOSS	dB	?		?
19. TOTAL FIXED LOSSES	dB	4.8		4.8
20. TOTAL LOSSES(PATH AND FIXED)	dB		152.3	
21. ANTENNA DIAMETER	Feet	12.0		12.0
22. ANTENNA TYPE		SOLID		SOLID
23. ANTENNA GAIN	dBi	45.8		45.8
24. TOTAL ANTENNA GAINS	dB		91.6	
25. NET SYSTEM LOSS	dB		60.7	
26. RADIO EQUIPMENT TYPE AND CAPACITY			DIGITAL 672	
27. MINIMUM TRANSMITTER POWER	dBm		30.0	
28. RECEIVER THRESHOLD	dBm		-69.0	
29. NET SYSTEM GAIN	dB		99.0	
30. MEDIAN RECEIVED POWER	dBm		-30.7	
30. FLAT FADE MARGIN	dB		38.3	
31. DISPERSIVE F.M. (DIG. ONLY)	dB		42.0	
32. COMPOSITE FADE MARGIN	dB		36.7	
WEIGHTED RAYLEIGH PROPAGATION RELIABILITY FOR ATMOSPHERIC MULTIPATH				
TERRAIN/CLIMATE FACTOR	0.25 TO 6			6.0
MEAN ANNUAL TEMPERATURE	Deg F			68.0
DIVERSITY SPACING	Feet			30.0
NON-DIVERSITY OUTAGE TIME	Sec/yr			6294.8
NON-DIVERSITY AVAILABILITY	Percent			99.98004
SPACE DIVERSITY IMPROV. FACTOR	Decimal			66.3
SPACE DIVERSITY OUTAGE TIME	Sec/yr			94.9
SPACE DIVERSITY AVAILABILITY	Percent			99.99970
BELL SHORT HAUL OBJECTIVE	Sec/yr			192.0

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US DEPARTMENT of COMMERCE
MICROWAVE RADIO PATH CALCULATION SPREADSHEET 30-Jul-92

PROJECT NAME		?			
ENGINEER		?			
FREQUENCY (GHz)		1.90			
1. SITE NAME		?		?
3. LATITUDE, North,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
4. LONGITUDE, West,	Degrees	?		?
	Minutes	?		?
	Seconds	?		?
5. SITE ELEVATION, AMSL	Feet	?		?
6. AZIMUTH FROM NORTH	Degrees	0.0		0.0
7. PATH LENGTH	Miles		30.0	
8. PATH ATTENUATION	dB		131.7	
10. TOWER TYPE		?		?
11. ANTENNA HEIGHT,AGL	Feet	100		100
12. TRANSMISSION LINE LENGTH	Feet	110		110
13. TRANS. LINE TYPE		7/8" FOAM		7/8" FOAM
14. TRANS. LINE LOSS	dB/100'	2.00		2.00
15. TRANSMISSION LINE LOSS	dB	2.2		2.2
16. MISCELLANEOUS LOSSES	dB	0.5		0.5
17. PROTECTED TERMINAL LOSS	dB	?		?
18. DIVERSITY RECEPTION LOSS	dB	?		?
19. TOTAL FIXED LOSSES	dB	2.7		2.7
20. TOTAL LOSSES(PATH AND FIXED)	dB		137.1	
21. ANTENNA DIAMETER	Feet	8.0		8.0
22. ANTENNA TYPE		GRID		GRID
23. ANTENNA GAIN	dBi	31.3		31.3
24. TOTAL ANTENNA GAINS	dB		62.7	
25. NET SYSTEM LOSS	dB		74.4	
26. RADIO EQUIPMENT TYPE AND CAPACITY			ANALOG 600	
27. MINIMUM TRANSMITTER POWER	dBm		32.0	
28. RECEIVER THRESHOLD	dBm		-80.0	
29. NET SYSTEM GAIN	dB		112.0	
30. MEDIAN RECEIVED POWER	dBm		-42.4	
30. FLAT FADE MARGIN	dB		37.6	
31. DISPERSIVE F.M. (DIG. ONLY)	dB		?	
32. COMPOSITE FADE MARGIN	dB		37.6	

WEIGHTED RAYLEIGH PROPAGATION RELIABILITY FOR ATMOSPHERIC MULTIPATH

TERRAIN/CLIMATE FACTOR	0.25 TO 6			0.25
MEAN ANNUAL TEMPERATURE	Deg F			50.0
DIVERSITY SPACING	Feet			60.0
NON-DIVERSITY OUTAGE TIME	Sec/yr			45.3
NON-DIVERSITY AVAILABILITY	Percent			99.99986
SPACE DIVERSITY IMPROV. FACTOR	Decimal			90.9
SPACE DIVERSITY OUTAGE TIME	Sec/yr			0.5
SPACE DIVERSITY AVAILABILITY	Percent			100.00000
BELL SHORT HAUL OBJECTIVE	Sec/yr			192.0

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